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The Selma, Alabama, Chondrite

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HISTORY

The Selma, Alabama, chondrite was found by J. W. Coleman about 2 miles north-northwest of Selma, in Dallas County, in March, 1906. It was a single stone weighing 140.6 kg. (310 lbs.), and at that time was one of the largest stone meteorites known, although it has since been eclipsed by such meteorites as Paragould (820 lbs.) and Norton County (2360 lbs.). The find was first mentioned in the literature by Merrill (1906), who later (1907, 1916) gave a detailed description of its mineralogical and chemical composition. The stone was purchased by the American Museum of Natural History, and Hovey, the Curator of Geology at that time, described it in the Museum's Journal (1907).

From the descriptions it appears that the stone was unearthed during the digging of a trench and was rolled to one side and lay exposed for some time before it was recognized as a meteorite. The finder suggested that it fell on July 20, 1898, when a brilliant meteor was seen in that part of the country. Hovey believed that this was probable, but our examination of the interior of the stone shows that it is oxidized throughout. The degree of alteration seems too great for a compact stone that had fallen less than eight years previously, and it probably fell prior to white settlement.

As Wahl (1950a) pointed out, the original analysis by Whitfield

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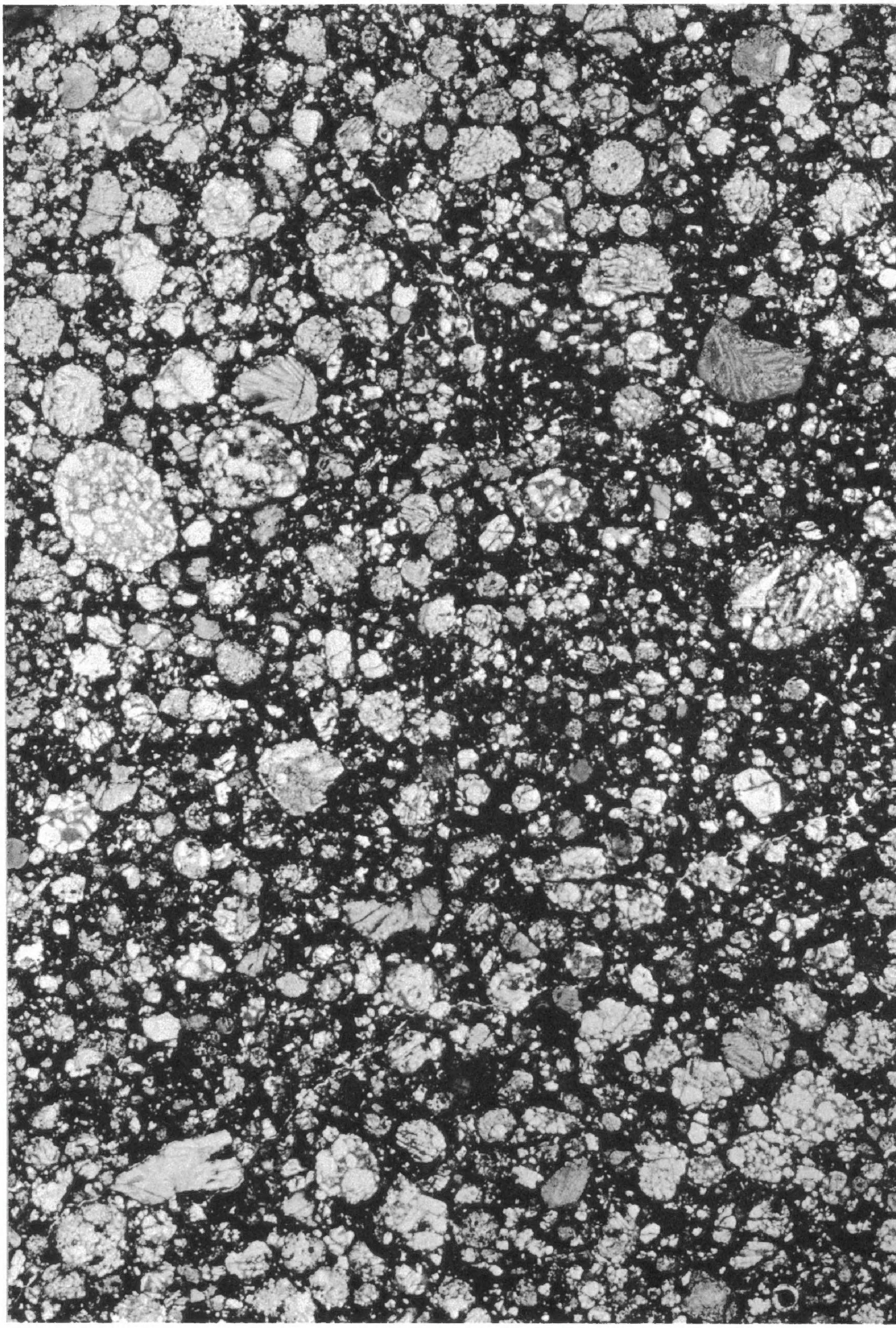

FIG. 1. Photomicrograph of the Selma meteorite. Chondrules of granular olivine and fibrous and prismatic hypersthene in an opaque ground mass. The largest chondrule is 1.5 mm. in diameter.

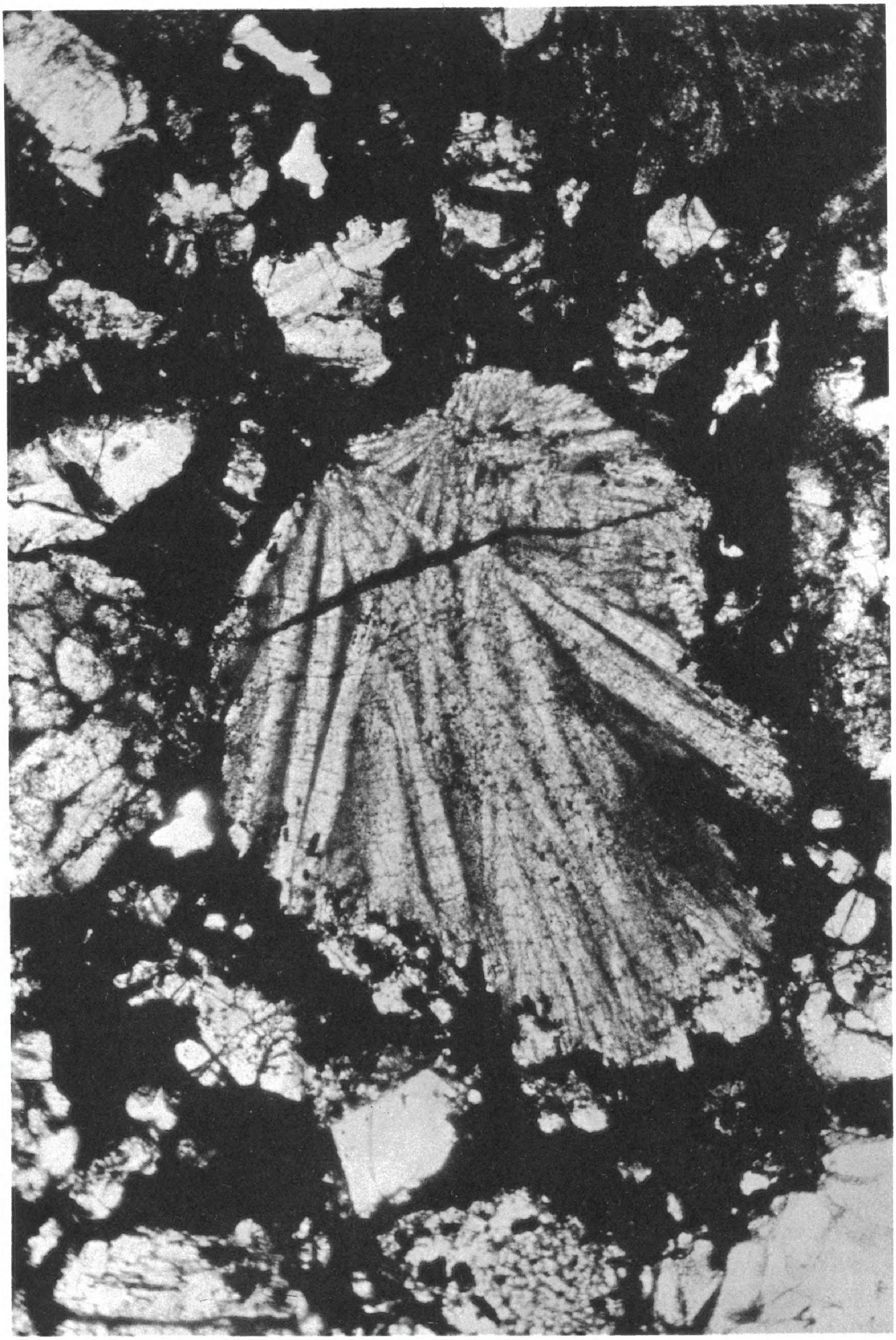

FIG. 2. Photomicrograph of chondrule of radiating prismatic hypersthene. The chondrule has a diameter of 1 mm.

(Merrill, 1916) is unsatisfactory in several respects, especially in the high content of Na_2O (3.96%). As the original portion analyzed was from the surface of the meteorite, which is much weathered, it was decided to repeat the analysis on a sample from the interior. The Department of Public Works of the City of New York kindly took a diamond drill core 1½ inches in diameter through the stone, and a piece from the center was selected for analysis. Unfortunately, even this sample proved to be considerably altered, all the nickel-iron having gone to iron oxide. Nevertheless, it was decided to proceed with the analysis and to reëxamine the mineralogy of the stone.

MINERALOGICAL COMPOSITION

The minerals identified in the meteorite are olivine, hypersthene, plagioclase, troilite, and magnetite; the nickel-iron originally present has been completely altered to limonitic material. A small amount (less than 1%) of a phosphate mineral (apatite or merrillite) is probably present. Notes on the minerals follow:

OLIVINE: The refractive indices are: $\alpha = 1.670$, $\gamma = 1.710$, indicating a composition of Fo_{81}, according to the determinative curve of Poldervaart (1950). With the X-ray method of Yoder and Sahama (1957), the composition was found to be Fo_{80}.

HYPERSTHENE: The refractive indices are: $\alpha = 1.670$, $\gamma = 1.681$, indicating a composition of En_{84}, according to the determinative curve of Kuno (1954).

PLAGIOCLASE: This mineral, which is present in a small amount, was isolated by the digesting of a sample of the meteorite powder in 1:1 HCl (thereby dissolving iron oxides, troilite, and olivine), and the centrifuging of the residue in an acetone-methylene iodide mixture of density 2.9. The light fraction was a concentrate of plagioclase. Its refractive indices are: $\alpha' = 1.545$, $\gamma' = 1.553$, indicating a composition of An_{34}.

MAGNETITE: This mineral occurs as small (< 0.1 mm. in diameter) black grains with a brilliant luster, enclosed in olivine and hypersthene. It appears to be a primary constituent and not formed by the weathering and oxidation which have affected this meteorite. It is highly magnetic and has a black streak. Chromite was not identified in this meteorite, and the Cr_2O_3 found by chemical analysis is probably in solid solution in the magnetite.

A thin section of the meteorite shows that it consists of chondrules, averaging 1 mm. in diameter, of granular olivine and prismatic, often

radiating hypersthene, set in a ground mass of olivine, hypersthene, and opaque material (figs. 1 and 2). The stone is hard and compact, in spite of the extensive weathering it has undergone, and takes a good polish. The chondritic structure of this meteorite is extremely well developed and is clearly visible to the naked eye on a cut surface.

The density of a piece of this stone was determined by measuring the apparent loss of weight on suspension in carbon tetrachloride, and was found to be 3.45. This is slightly higher than the figure 3.42 given by Hovey (1907).

TABLE 1

CHEMICAL ANALYSIS OF THE SELMA METEORITE

A		B		C	
FeS	4.70	H	0.36	Na	0.62
SiO_2	34.80	C	0.043	Mg	23.68
TiO_2	0.123	O	39.61	Al	1.58
Al_2O_3	1.68	Na	0.35	Si	28.92
Cr_2O_3	0.45	Mg	13.32	P	0.30
Fe_2O_3	10.63	Al	0.89	K	0.09
FeO	15.01	Si	16.26	Ca	1.53
NiO	2.02	P	0.17	Ti	0.12
CoO	0.086	S	2.12	Cr	0.55
MnO	0.29	K	0.05	Mn	0.39
MgO	22.21	Ca	0.86	Fe	39.27
CaO	1.20	Ti	0.07	Co	0.12
Na_2O	0.47	Cr	0.31	Ni	2.83
K_2O	0.057	Mn	0.22		
P_2O_5	0.38	Fe	22.08		100.00
H_2O+	3.22	Co	0.068		
C	0.043	Ni	1.59		
SO_3	1.00				
			98.37		
	98.37				

A Chemical analysis expressed as troilite and oxides [all H as H_2O, all C as C (both free and combined)].

B Chemical analysis expressed as elements, with calculated figure for oxygen.

C Chemical analysis recalculated on a volatile-free (O, C, S, H) basis.

CHEMICAL COMPOSITION

The chemical analysis is given in table 1, in the conventional form, in terms of the individual elements, and recalculated on a volatile-free basis. The low summation (98.37) is probably due in large part to a low value for Fe_2O_3 and a high value for FeO. Selma is an almost insoluble

analytical problem in this respect, as it contains iron as sulphide (troilite), ferrous iron in silicates and magnetite, and ferric iron in magnetite and limonitic alteration products. The accurate analytical determination of iron in each of these forms is a problem that present techniques are inadequate to solve.

The normative mineral composition, expressed as weight percentages, is given in table 2. This has been calculated as suggested by Wahl (1950b), except that we prefer to calculate P_2O_5 as apatite, not merrillite; the composition of merrillite is not well established, being based on a single analysis of a small amount of impure material, and this mineral may well be a variety of apatite.

TABLE 2

NORMATIVE MINERAL COMPOSITION OF THE SELMA METEORITE

Olivine	39.65%
Hypersthene	27.42%
Diopside	0.95%
Albite	3.98%
Anorthite	2.28%
Orthoclase	0.33%
Apatite	0.91%
Chromite	0.67%
Ilmenite	0.23%
Fe_2O_3, NiO, SO_3, H_2O+	16.87%

The normative mineral composition correlates well with the observed mineral composition. No diopside was seen, but the small amount of this component is probably in solid solution in the hypersthene. Normative pyroxene is 28.37 per cent, normative olivine 39.65 per cent, giving a ratio of pyroxene to olivine of 2:3, which agrees with estimates from thin sections and X-ray powder photographs. The proportions of FeO to MgO in the normative pyroxene and olivine are somewhat higher than in the minerals themselves. As mentioned above, this probably means that FeO in the chemical analysis is somewhat higher than the true figure. Normative feldspar is 6.59 per cent, probably somewhat higher than the actual amount of plagioclase, as some of the Al_2O_3 calculated as feldspar will be in the pyroxene. The 0.67 per cent normative chromite may be in solid solution in magnetite. Although neither apatite nor merrillite was observed in thin section, the 0.91 per cent apatite in the norm could well be present. It would be extremely difficult to recognize in a thin section, as it probably occurs in small grains intimately mixed with pyroxene and olivine.

The mineralogical composition and the proportion of MgO to FeO shows that the Selma meteorite, in Prior's classification (1920), falls into his group of hypersthene-olivine chondrites of the Baroti and Soko-Banja types.

ACKNOWLEDGMENTS

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